RICARDO-AEA

QA/QC Data Ratification Report for the Automatic Urban and Rural Network, July-September 2014 and Intercalibration Report, Summer 2014

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Executive summary

Ricardo-AEA carries out the quality assurance and quality control (QA/QC) activities for the Automatic Urban and Rural Monitoring Network (AURN) on behalf of the UK Department for Environment, Food and Rural Affairs (Defra), Scottish Government, Welsh Government and Department of Environment (DoE) in Northern Ireland.

Ratified hourly average data capture for the network averaged 85.94% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 3-month reporting period July-September 2014. Average data capture for all pollutants except $PM_{2.5}$ and PM_{10} were above 85%. There were 36 stations with data capture less than 85% for the period.

A total of 139 monitoring stations in the AURN operated during this quarter. Some of these are co-located and separately named gravimetric particulate analysers at stations with automatic analysers. Many affiliated stations have additional Defra-funded analysers installed on site.

The main reasons for data loss at the stations have been provided and these were predominantly due to instrument or air conditioning faults, response instability or problems associated with the replacement of analysers and infrastructure.

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Section A: Data Ratification, July-September 2014

1 Introduction

This quarterly report covers the Quality Assurance and Quality Control (QA/QC) activities undertaken by Ricardo-AEA to ratify automatic monitoring data from Defra and the Devolved Administrations' Automatic Urban and Rural Network (AURN) for the period 1 July- 30 September 2014. Eleven stations also use non-automatic gravimetric particulate samplers (Partisols); there are 17 of these in the network. Eight of them are co-located with FDMS analysers at Auchencorth Moss, Harwell, London North Kensington and Marylebone Road for both PM_{10} and $PM_{2.5}$.

1.1 Overview of Network performance

Ratified hourly average (daily average for Partisols) data capture for the network averaged 85.94% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 3 month reporting period July-September 2014 (see Table 1.1). Data capture statistics are calculated using the actual data capture as hourly averages (daily for Partisol) against the total number of hours (or days) in the relevant period; service and maintenance are counted as lost data. It is permissible to discount routine service and calibration from achievable data capture targets, but this is not yet calculated. For stations starting or closing during the period, the data capture is based on the actual date starting or closing. All except $PM_{2.5}$ and PM_{10} achieved 85% or higher data capture on average. The data capture target for the purposes of monitoring compliance with the EU Air Quality Directive (Directive 2008/50/EC) is 90% excluding planned servicing and maintenance. For practical purposes in the AURN, planned maintenance is assumed to be 5% so a target of 85% data capture is used.

Table 1.1: AURN Ratified Data Capture (%) by Quarter, 2014

	CO	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	Mean
Q1 2014	95.35	85.45	83.51	94.31	95.01	90.02	89.72
Q2 2014	99.75	83.40	89.99	91.98	95.43	91.07	89.41
Q3 2014	86.65	80.07	78.89	87.16	93.33	94.85	85.94

1.2 Changes to Ratified Data

The following data from previous quarters have been changed as a result of the ratification process for this quarter:

- Armagh Roadside PM_{10} 22 May-30 June 2014, low volatile concentrations
- Harwell PM_{10} 18-30 June 2014, step change in volatile concentrations
- Ladybower NOx, 27 May-30 June 2014, analyser faults
- London Teddington Bushy Park $PM_{2.5}$, 18-22 June 2014, leak in mass transducer
- Oxford St Ebbes PM10 28 May-30 June 2014, low volatiles
- Port Talbot Margam $PM_{2.5}$, 27 March-30 June 2014, leak
- Sunderland Silksworth NOx, 1 April-30 June 2014, data reinstated
- Wirral Tranmere NOx, 1 Jan 2013-30 June 2014, sampling fault
- Warrington $PM_{2.5}$, 6-30 June 2014, high zero test result

A list of changes to ratified data is given at http://uk-air.defra.gov.uk/data/changes-to-ratified-data .

1.3 Precision of Measured Data

As part of the requirements of INSPIRE, data is required to be reported to one decimal place (two for CO). As of September 2014, a number of sites are still reporting gaseous data as integers. These are:

Armagh Roadside
Carlisle Roadside
Newcastle Cradlewell Roadside
Newport
Scunthorpe (to 0.5ppb)
Sunderland Silksworth
Warrington
Salford Eccles
York Fishergate

The relevant ESUs have been instructed to reconfigure loggers to record data to one decimal place.

2 Changes in Network for Directive Compliance

The Narberth site was moved to a new location at the service on 11 August to avoid sampling emissions from farming machinery.

3 Station Specific Issues

In this section, we now discuss in turn specific station issues for the following geographic groupings – London, England (excluding London), Scotland, Northern Ireland and Wales. Where analysers were commissioned during the period, the stated data capture for these instruments is calculated from the date of commissioning. Analysers with data capture less than 90% are highlighted in yellow and those with data capture less than 85% are highlighted in orange.

3.1 London

3.1.1 Data Capture

The data capture for the sites in London (within the M25) is given in Table 3.1

Table 3.1 London Data Capture

	CO	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	Mean
Camden Kerbside		58.97	59.24	99.55			72.58
Ealing Horn Lane		91.98					91.98
Haringey Roadside			49.82	0.00			24.91
London Bexley			88.86	94.16		90.13	91.05
London Bloomsbury		95.20	88.27	98.19	98.51	98.14	95.66
London Eltham			95.56	50.68	90.44		78.89
London Haringey Priory Park South				96.69	91.08		93.89
London Harlington		94.20	94.43	95.47	98.73		95.71
London Harrow Stanmore			96.78				96.78
London Hillingdon				94.29	98.60		96.44
London Marylebone Road	98.32	92.98	93.03	99.23	97.19	93.30	95.67

	CO	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	Mean
London Marylebone Road (Partisol)		96.74	98.91				97.83
London N. Kensington	99.46	32.38	23.05	99.64	99.59	88.59	73.78
London N. Kensington (Partisol)		98.91	98.91				98.91
London Teddington				98.23	97.64		97.94
London Teddington Bushy Park			0.00				0.00
London Westminster			98.91	98.32			98.35
Southwark A2 Old Kent Road		0.00		0.00			0.00
Tower Hamlets Roadside				99.32			99.32
Number of Sites	**2**	**9**	**13**	**14**	**8**	**4**	**19**
Number of sites < 85 %	**0**	**3**	**4**	**3**	**0**	**0**	**7**
Number of sites < 90%	**0**	**3**	**6**	**3**	**0**	**1**	**7**
Network mean	**98.89**	**62.49**	**75.83**	**80.27**	**96.47**	**92.54**	**76.33**

3.1.2 Principal Reasons for Data Loss

Camden Kerbside

The air conditioning unit failed during the summer, and the $PM_{2.5}$ analyser was switched off for much of the summer period. Data from the PM_{10} analyser was unstable and have been deleted this quarter up to replacement of the air conditioning unit on 3 August.

Haringey Roadside

The NOx analyser suffered a variety of faults during the quarter, and the Equipment Support Unit (ESU) failed to adequately rectify them In addition there were very few reliable calibrations carried out; as a result, all data for this quarter have been deleted. In addition, the $PM_{2.5}$ FDMS analyser was serviced in error on 18 August, which introduced a fault. At the QA/QC audit on 3 September, it was found that the sharp cut cyclone had not been fitted, presumably since the service. Data from 10 August to the scheduled service on 29 September have been deleted.

London Eltham

The ozone generator in the NOx analyser failed on 19 August. The ESU removed the analyser for repair, and finally returned the analyser to site on 17 December. In addition, the $PM_{2.5}$ analyser suffered frequent drier faults; the drier was replaced on 14 November.

London North Kensington

Both FDMS analysers gave high responses during the zero tests in July. The PM_{10} data have been deleted from 22 July to the drier replacement on 22 September; the $PM_{2.5}$ data have been deleted from 22 July to the end of the quarter. Further data loss is likely in Q4.

London Teddington Bushy Park

The poor quality $PM_{2.5}$ data issues remain in this quarter; all data have been deleted. The mass transducer was broken during the QA/QC audit on 14 August; repairs were completed on 30 September.

Southwark A2 Old Kent Road

The site remained closed for the entire quarter due to impending enclosure replacement.

3.2 England (excluding London)

3.2.1 Data Capture

	CO	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	Mean
Barnsley Gawber				98.10	98.05	97.69	97.95
Barnstaple A39		97.64	81.07				89.36
Bath Roadside				98.32			98.32
Billingham				89.86			89.86
Birmingham Acocks Green			96.33	98.14	98.64		97.71
Birmingham Tyburn		91.03	94.07	98.46	98.51	97.74	95.96
Birmingham Tyburn Roadside		94.97	93.93	95.79	97.42		95.53
Blackburn Accrington Road				99.41			99.41
Blackpool Marton			75.63	94.25	98.46		89.45
Bottesford					93.66		93.66
Bournemouth			44.57	46.60	46.56		46.54
Brighton Preston Park			94.57	98.51	98.64		98.49
Bristol St Paul's		87.64	0.00	77.81	97.69		65.78
Cambridge Roadside				74.68			74.68
Canterbury				97.83	98.64		98.23
Carlisle Roadside		53.53	52.22	62.32			56.02
Charlton Mackrell				98.37	99.50		98.94
Chatham Centre Roadside		92.26	92.80	93.84			92.96
Chesterfield Roadside		95.43	90.13	78.89			88.15
Coventry Allesley			92.48	98.46	98.41		96.45
Eastbourne		37.14	37.18	41.49			38.60
Exeter Roadside				89.09	89.40		89.24
Glazebury				81.79	98.82		90.31
Great Dun Fell					99.68		99.68
Harwell		35.37	96.47	99.23	99.82	99.73	86.12
Harwell		92.39	97.83				95.11
High Muffles				80.21	75.77		77.99
Honiton				98.41			98.41
Horley				95.02			95.02
Hull Freetown		61.78	91.35	97.33	97.55	97.42	89.09
Ladybower				52.58	94.88	94.61	80.69
Leamington Spa		93.98	95.02	94.02	98.69		95.43
Leamington Spa Rugby Road		53.67	94.07	97.60			81.78
Leeds Centre	97.15	94.38	93.61	92.66	97.15	92.71	94.61
Leeds Headingley Kerbside		76.63	94.52	98.55			89.90
Leicester University			96.56	86.78	97.96		93.77
Leominster				37.27	97.92		67.60
Lincoln Canwick Road				98.51			98.51
Liverpool Queen's Drive Roadside				98.41			98.41
Liverpool Speke		87.50	91.89	97.24	97.33	97.15	94.22

	CO	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	Mean
Lullington Heath				22.28	98.46	94.43	71.72
Manchester Piccadilly			94.02	94.11	97.28	96.78	95.55
Manchester South				98.37	98.41		98.39
Market Harborough				94.16	98.01		96.08
Middlesbrough		92.57	91.26	44.57	97.51	97.92	84.76
Newcastle Centre		41.12	40.13	37.09	42.84		40.30
Newcastle Cradlewell Roadside				95.43			95.43
Northampton Kingsthorpe			100.00	98.37	95.88		97.18
Norwich Lakenfields		96.24	90.26	98.46	98.64		95.90
Nottingham Centre		87.68	92.26	97.42	97.42	82.74	91.50
Oldbury Birmingham Road				73.05			73.05
Oxford Centre Roadside				99.28			99.28
Oxford St Ebbes		45.06	92.48	99.41			78.99
Plymouth Centre		94.93	75.91	96.42	98.46		91.43
Portsmouth		82.97	85.55	88.54	98.69		88.94
Preston			42.44	50.86	50.86		48.05
Reading New Town		95.79	68.98	98.32	98.51		90.40
Rochester Stoke		94.79	93.52	98.28	98.51	94.25	95.87
Salford Eccles		97.10	96.97	94.25			96.11
Saltash Callington Road		93.61	20.79				57.20
Sandy Roadside		0.00	82.07	88.13			56.73
Scunthorpe Town		88.18		99.05		99.32	95.52
Shaw Crompton Way				79.44			79.44
Sheffield Devonshire Green		61.68	94.43	99.68	99.68		88.87
Sheffield Tinsley				86.37			86.37
Sibton					99.82		99.82
Southampton Centre		94.84	94.97	97.28	96.83	93.30	95.44
Southend-on-Sea			0.59	89.63	91.89		60.70
St Osyth				93.80	97.60		95.70
Stanford-le-Hope Roadside		95.11	88.00	98.69			93.93
Stockton-on-Tees Eaglescliffe		82.84	93.84	98.51			91.73
Stoke-on-Trent Centre		91.76	96.24	96.42	98.78		95.80
Storrington Roadside		84.10	84.51	97.96			88.86
Sunderland Silksworth			48.32	62.05	61.55		57.31
Thurrock		98.05		98.60	98.69	98.37	98.43
Walsall Woodlands				99.77	99.91		99.84
Warrington		91.67	58.92	99.59			83.39
Weybourne					99.91		99.91
Wicken Fen				93.34	93.39	93.12	93.28
Wigan Centre			67.75	95.83	91.85		85.14
Wirral Tranmere			97.01	98.05	98.37		97.81
Yarner Wood				81.20	81.16		81.18
York Bootham		97.33	97.01				97.17
York Fishergate		96.47	96.65	96.33			96.48

	CO	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	Mean
Number of Sites	**1**	**39**	**50**	**76**	**52**	**16**	**84**
Number of sites < 85 %	**0**	**13**	**17**	**18**	**6**	**1**	**22**
Number of sites < 90%	**0**	**17**	**19**	**25**	**7**	**1**	**35**
Network mean	**97.15**	**80.75**	**79.62**	**87.69**	**93.23**	**95.45**	**87.18**

3.2.2 Principal Reasons for Data Loss

Barnstaple A39

The $PM_{2.5}$ cyclone was found to have been removed when the sampling head was replaced following zero checks on 14 July. Some further data were lost in September following a cooler fault.

Billingham

A poorly performing NOx converter was identified in August, following replacement of the converter in June. Data between 11 and 16 August have been deleted.

Bournemouth

The power was turned off from 18 July to 4 September due to an electrical fault with the air conditioning unit.

Bristol St Pauls

The $PM_{2.5}$ analyser was relocated inside the cabin on 27 May to allow better roof access. Following this, the $PM_{2.5}$ data were unstable, and despite several visits, the analyser was removed for workshop repair, returning to service on 17 October.

Cambridge Roadside

The converter was found to be faulty at the QA/QC audit, although it appeared to have rectified itself by the following service. Data between the audit and the service have been deleted.

Carlisle Roadside

The air conditioning unit failed causing a power cut on 24 July, followed by a considerable period of high cabin temperatures causing instrument faults and poor quality data.

High Muffles

All data were lost between 10 and 24 July due to a communication failure with the site.

Leamington Spa Rugby Road

The PM_{10} analyser was reinstalled at site on 27 July following workshop repair. Some further data were lost while the analyser settled down.

Sandy Roadside

The persistent problems with the PM_{10} analyser continued through this period, with the analyser ultimately removed for workshop repair. In addition some $PM_{2.5}$ data were lost due to a power failure, and from a slightly extended zero test.

Ladybower

The NOx analyser developed a fault on 22 July, and was removed from site for workshop repair. A loan analyser was installed on 29 July, but this too developed a fault, resulting in the loss of data up to 13 August.

Middlesbrough

The NOx filter holder was found to be leaking at the service on 20 August, data from 1 July to the service have been deleted.

Newcastle Centre

The station was closed from 4 August to 25 September for installation of a new cabin. Once site operation recommenced, a leak in the NOx sampling system resulted in internal sampling; the NOx data have been deleted up to the end of the quarter.

Oxford St Ebbes

Following deletion of data up to 28 May, the volatile PM_{10} data continue to be a regional outlier into this quarter, and data have been deleted up to 13 August.

Preston

The station was closed from 21 July to 2 September for installation of a new cabin.

Portsmouth

Both FDMS analysers gave very high baselines at the summer QA/QC audit. The PM_{10} data between 12 and 22 September, and the $PM_{2.5}$ data between At the QA/QC audit in October, it was found that the NOx analyser was connected to a redundant sample manifold, resulting in internal sampling. Data have been deleted from a suspected service on 2 September.

Saltash Callington Road

The $PM_{2.5}$ data have shown to be of poor quality throughout the quarter. The drier was replaced on 24 July, and following several further visits, data remained poor until a replacement mass transducer was fitted in October.

Sandy Roadside

The PM_{10} FDMS analyser continued to perform poorly for the duration of this quarter, ultimately being removed for workshop repair. All data for this quarter have been deleted. Further data loss in the fourth quarter is inevitable.

Shaw Crompton Way

A NOx converter fault was repaired on 17 July; data from 1 to17 July have been deleted.

Sheffield Devonshire Green

The PM_{10} FDMS suffered a valve failure from 8 July to 12 August.

Sheffield Tinsley

The analyser suffered a converter temperature fault which was repaired on 31 July; data from 24 July have been deleted

Southend on Sea

The drier in the $PM_{2.5}$ FDMS was identified as being faulty at the beginning of July; this drier was of a different type to most in the network, and a delay in obtaining a replacement resulted in the loss of data from 1 July to 17 October.

Sunderland Silksworth

The station was closed from 1 to 30 September for installation of a new cabin.

Warrington

The air conditioning unit failed, resulting in the loss of data from 7 to 25 July. A suspected $PM_{2.5}$ valve failure on 27 August was repaired on 1 September, but a further fault required a return visit, finally fixed on 8 September

Wigan Centre

The $PM_{2.5}$ zero check was rather longer than intended, from 20 August to 2 September; following this, incorrect filters were installed, and data up to 9 September were deleted during ratification.

Yarner Wood

The station was closed from 26 August to 12 September for installation of a new cabin.

3.3 Scotland

3.3.1 Data Capture

The data capture for the sites in Scotland is given in Table 3.3

Table 3.3 Data Capture-Scotland

	CO	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	Mean
Aberdeen		64.90	82.16	86.96	99.05		83.27
Aberdeen Union Street Roadside				88.54			88.54
Auchencorth Moss (Partisol)		98.91	96.74		98.46		98.41
Auchencorth Moss		94.20	82.93				88.56
Bush Estate				95.29	98.69		96.99
Dumbarton Roadside				98.55			98.55
Dumfries				98.41			98.41
Edinburgh St Leonards	44.20	72.92	73.01	77.17	77.17	76.99	70.24
Eskdalemuir				98.78	98.82		98.80
Fort William				97.92	98.05		97.98
Glasgow Great Western Road				99.82			99.82
Glasgow Kerbside		82.29	45.29	98.28			75.29
Glasgow Townhead		92.03	85.28	98.32	98.41		93.51
Grangemouth		95.92	96.56	98.37		97.33	97.04
Grangemouth Moray				75.77			75.77
Inverness		93.48	98.91	98.60			98.41
Lerwick					0.00		0.00
Peebles				98.46	98.51		98.48
Strath Vaich					99.64		99.64
Number of Sites	**1**	**8**	**8**	**15**	**10**	**2**	**19**
Number of sites < 85 %	**1**	**3**	**4**	**3**	**2**	**1**	**5**
Number of sites < 90%	**1**	**3**	**5**	**5**	**2**	**1**	**7**
Network mean	**44.20**	**77.18**	**82.61**	**93.27**	**86.68**	**87.16**	**87.25**

3.3.2 Principal Reasons for Data Loss

Aberdeen

Both FDMS analysers showed excessively high sample dewpoints during the quarter, and the PM_{10} analyser also gave a high zero result at the summer audit. The PM_{10} data have been deleted from 13 August to 10 September; a new drier was fitted on 3 September. The $PM_{2.5}$ data were also deleted from 18 August to 3 September; possibly cabin temperatures were too high. Some NOx data was lost due to a pump fault in July.

Aberdeen Union Street Roadside

Data were deleted from 7 to 15 July due to a pump fault

Edinburgh St Leonards

The station was closed from 12 September to 11 December for installation of a new cabin.

Glasgow Kerbside

The poor performance of the FDMS analysers, particularly the $PM_{2.5}$, continued this quarter; leaks in both analysers were found at the summer audit. The driers were replaced on 8 August which resulted in improved data.

Grangemouth Moray

A communications fault resulted in the loss of data from 4 to 13 September. In addition, the run-on of the overnight span check resulted in the loss of one hour's data each night.

Lerwick

Lerwick remained closed due to relocation of the site.

3.4 Wales

3.4.1 Data Capture

The data capture for the sites in Wales is given in Table 3.4

Table 3.4 Data Capture-Wales

	CO	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	Mean
Aston Hill				94.20	98.32		96.26
Cardiff Centre	97.51	84.65	93.16	97.37	97.46	97.10	94.54
Chepstow A48		96.78	78.22	69.25			81.42
Cwmbran				98.41	99.95		99.18
Narberth		67.12		97.37	97.24	97.37	89.78
Newport		92.75	93.39	93.93			93.36
Port Talbot Margam (Partisol)		98.91					98.91
Port Talbot Margam	96.60	89.76	0.00	70.56	96.78	96.65	75.06
Swansea Roadside		91.08	91.89	98.19			93.72
Wrexham		84.78	69.57	82.25		97.51	89.37
Number of Sites	**2**	**8**	**6**	**9**	**5**	**4**	**10**
Number of sites < 85 %	**0**	**3**	**3**	**3**	**0**	**0**	**3**
Number of sites < 90%	**0**	**4**	**3**	**3**	**0**	**0**	**5**
Network mean	**97.06**	**88.23**	**71.04**	**89.06**	**97.95**	**97.16**	**91.16**

3.4.2 Principal Reasons for Data Loss

Chepstow A48

A fault with the memory storage in the NOx analyser resulted in the loss of data from 8 August to 2 September. In addition, the PM2.5 data were poor from the service on 4 August up to a callout on 21 August, when the sensor unit was replaced; data have been deleted between the visits.

Narberth

The PM_{10} volatile concentrations were identified as a regional outlier up to 29 July; data up to this point have been deleted during ratification.

Port Talbot Margam

A leak was discovered in the $PM_{2.5}$ FDMS at the service on 2 September. The data remained low until a further visit to retune the amplifier board on 20 November. Data have been deleted back to 26 January.

Wrexham

The NOx analyser appears to have been sampling internally from 12 to 26 August. The $PM_{2.5}$ Partisol pump failed on 6 July; 23 days data were lost. The PM_{10} Partisol suffered a number of filter exchange faults in July and August, and both sets of filters were returned wet up to 12 August.

3.5 Ireland

3.5.1 Data Capture

Table 3.5 Data Capture-Ireland

	CO	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	Mean
Armagh Roadside		27.67		0.00			13.84
Ballymena Ballykeel						98.19	98.19
Belfast Centre	73.32	94.07	94.20	92.71	97.10	98.28	91.61
Belfast Stockman's Lane		98.60		98.64			98.62
Derry		96.47	84.19	94.88	99.50	93.70	93.75
Lough Navar		95.70			99.73		97.71
Mace Head					100.00		100.00
Number of Sites	**1**	**5**	**2**	**4**	**4**	**3**	**7**
Number of sites < 85 %	**1**	**1**	**1**	**1**	**0**	**0**	**1**
Number of sites < 90%	**1**	**1**	**1**	**1**	**0**	**0**	**1**
Network mean	**73.32**	**82.50**	**89.20**	**71.56**	**99.08**	**96.72**	**84.82**

3.5.2 Principal Reasons for Data Loss

Armagh Roadside

The NOx data have been deleted for the quarter as there were apparently no calibrations carried out for more than 3 months, and there is no evidence that the filter had been changed during this period.

The volatile PM_{10} data look low compared to other local sites, and despite requests to the ESU to attend, no repairs were carried out. Data from 22 May to 3 September have been deleted.

4 Particle Analyser Zero Checks

As part of the QA/QC remit for continuous improvement, an ad hoc study of PM analyser baseline response has been undertaken for the past 2 years. This study has been coordinated following investigations of issues identified both by CMCU during routine operation and by QA/QC unit during the ratification process.

The study initially concentrated on FDMS analysers, examining the baseline profile of the reference channels and the relationship with other neighbouring monitoring stations. It has become clear that, on a daily mean basis, regional reference PM concentrations regularly reach a minimum value that approaches 0 μgm^{-3}. The test is equally valid for BAM instruments, and thus the tests are also carried out on these.

With this information, stations where this observation was not true were “zero calibrated” using high efficiency scrubbers installed on the sample inlets. The results of these calibrations have been used to compare against the analyser baseline responses and, in all comparisons, calibration and baseline show excellent agreement.

The detection limit is calculated by multiplying the standard deviation of the zero calibration by 3.3. Typical results show that a healthy FDMS or BAM should have a detection limit of less than 5µgm^{-3}.

Recent European guidance (CEN TS16450) provides a recommendation that zero tests on PM analysers should yield a result no higher than 3 µgm^{-3}, which provides the AURN with a robust performance limit for data ratification.

Section B: Summer 2014 Intercalibration

4 Introduction

During July to September 2014, Ricardo-AEA undertook an intercalibration of 134 monitoring stations in operation in the Defra and the Devolved Administrations Automatic Urban and Rural Monitoring Network. The intercalibration exercise is a vital step in the process of data ratification. The audits are used to undertake a number of analyser and infrastructure performance checks that cannot be performed by Local Site Operators, with a view to ensuring confidence in the accuracy, consistency and traceability of air pollution measurements made at all the monitoring stations.

The intercalibration requires the coordination and close cooperation of QA/QC unit, Management Units, ESU's and LSO's in making sure the entire operation runs smoothly and is the result of many months of planning. Leading up to the intercalibration, a draft schedule of visits is prepared and circulated to MU's and ESU's for approval. ESU ozone photometers are calibrated at Ricardo-AEA and all QA/QC equipment and cylinders are tested, calibrated and verified before use.

QA/QC visits are always undertaken before any ESU visits, to allow the performance of the sites to be quantified for the six month period prior to the visit. During the QA/QC visit, the LSO usually attends to demonstrate their competence in performing routine calibrations. The audits are used to transport independent calibration standard gases and test apparatus to all of the sites, to quantify the performance of the entire measurement process at the monitoring stations. The results obtained from these tests are fed into the ratification process, where any correction of datasets can be applied to account for any performance anomalies.

ESU visits are normally undertaken within a three week period following the QA/QC visit. At this time, the analysers and sampling systems are all cleaned and serviced in accordance with manufacturer's specifications. The analysers are then set up ready for the following six month period, until the next round of intercalibrations and servicing.

This scheduling has proven to be very successful in delivering reliable operation of monitoring stations and high quality data. The programme is iterative: improvements and enhancements are continually added to further improve performance and analyse results.

5 Scope of Intercalibration Exercise

The QA/QC visits fulfil a number of important functions:

- A "health check" on the production of provisionally scaled data, which is rapidly disseminated to the public soon after collection.
- Identification of poorly performing analysers and infrastructure, together with recommendations for corrective action.
- A measure of network performance, by examining for example, how different NOx analysers around the network respond to a common gas standard. This test checks how "harmonised" UK measurements are; ie that a 200ppb NO_2 pollution episode in Belfast would be reported in exactly the same way at every other site in the UK, regardless of the location or the analyser used to record the event.
- Assessment of the area around the monitoring station: has the environment changed in the last six months? Is the location still representative of the site classification?

The QA/QC audits test the following aspects of analyser performance:

1. Analyser accuracy and precision. These are basic checks to ensure analysers respond to known concentrations of gases in a reliable manner.
2. Instrument linearity. This test refines the response checks on analysers, by assessing whether doubling a concentration of gas to the analyser results in a doubling of the analyser signal response. If an analyser's response characteristics are not linear, data cannot be reliably

scaled into concentrations.

3. Instrument signal noise. This test checks that an analyser responds to calibration gases in a stable manner with time. A "noisy" analyser may not provide high quality data which may be difficult to process at lower concentrations.
4. Analyser response time. This test checks that the analyser responds quickly to a change in gas concentrations. If analyser response is too slow, data may not accurately reflect ambient concentrations.
5. Leak and flow checks. These tests ensure that ambient air reaches the analysers, without being compromised in any way. Leaks in the sampling system can affect the ability of the analyser to sample ambient air reliably.
6. NOx analyser converter efficiency. This test evaluates the ability of the analyser to measure NO_2. An inefficient converter severely compromises the data from the analyser.
7. FDMS k_0 evaluation. The analyser uses this factor to calculate mass concentrations, so the value is calculated to determine its accuracy compared to the stated value.
8. Particulate analyser flow rate checks. These tests ensure that the flow rates through critical parts of the analyser are within specified limits. There are specific analyser flow rates that are set to make sure particle size fractions and mass concentration calculations are performed correctly.
9. SO_2 analyser hydrocarbon interference. This test evaluates the analyser's ability to remove interfering hydrocarbon gases from the sample gas. A failed test could have significant implications for analyser data.
10. Evaluation of site cylinder concentrations. These tests use a set of Ricardo-AEA certified cylinders that are taken to all the sites. The concentrations of the site cylinders are used to scale pollution datasets, so it is important to ensure that the concentrations of gases in the cylinders do not change.
11. Competence of Local Site Operators (LSO) in undertaking calibrations. As it is the calibrations by the LSO's that are used to scale pollution datasets, it is important to check that these are undertaken competently.
12. Zero "calibration" of all automatic PM analysers. This test allows the baseline performance of PM analysers to be evaluated, to determine whether any remedial action is required.

Once all data have been collected, a "Network Intercomparison" is conducted. This utilises the audit gas cylinders transported to each site in the Network. These cylinders are recently calibrated by the Calibration Laboratory at Ricardo-AEA, and allow us to examine how different site analysers respond when they are supplied with the same gas used at other sites. For ozone analysers, the calibration is undertaken with recently calibrated ozone photometers.

The technique used to process the intercomparison results is broadly as follows:

- The analyser responses to audit gas are converted into concentrations, using provisional calibration factors obtained from the Management Units on the day of the intercalibration. These factors are also used for the provisional data supplied to the web/interactive TV services.
- These individual results are tabulated, and statistical analyses undertaken (e.g. network average result, network standard deviation, deviation of individual sites from the network mean etc.).

These results are then used to pick out problem sites, or "outliers", which are investigated further to determine reasons and investigate possible remedies for the outliers. The definition of an outlier is an analyser result that falls outside the following limits:

- ±10% of the network average for NOx, CO and SO_2 analysers,
- ±5% of the reference standard photometer for Ozone analysers,
- ±2.5 % of the stated ko value for FDMS analysers,
- ±10% for particulate analyser flow rates,
- Particulate analyser average zero response within ±3.0 µg/m^3.
- ±10% for the recalculation of site cylinder concentrations.

Thus, the intercalibration investigates the quality of provisional data output by the Management Units for use in forecasting, interactive television services and the web. It also provides input into the ratification process by highlighting sites where close scrutiny of datasets is likely to be required.

Any outliers that are identified are rigorously checked to determine the cause, and any required corrective action to be taken, if necessary. There are a number of likely main causes for outlier results, as discussed below:

- Drift of an analyser between scheduled LSO calibrations. This is by far the most common cause of an outlier result, and one that is simply corrected for during ratification of data.
- Drift of site cylinder concentrations between intercalibrations. Site cylinders can sometimes become unstable, especially at low pressures. All site cylinder concentrations are checked every six months, and are replaced as necessary.
- Erroneous calibration factors. It can occasionally happen that an analyser calibration is unsuccessful, and results in unsuitable scaling factors being used to produce pollution datasets. These are identified and corrected during ratification.
- Pressurisation of the sampling system at the audit. Occasionally, an analyser can be very sensitive to small changes in applied flow rates of calibration gas. This is more difficult to identify and correct, and may have consequences for data quality.
- Leaks, sample switching valves, etc. Outliers can be generated if an analyser is not sampling ambient air properly. It is likely that if a leaking analyser is identified, data losses will result.

6 Results

The results section has been restructured to allow easier regional analysis. As well as a detailed national summary, a regional summary and breakdown outlier analysis is provided.

6.1 National Network Overview

6.1.1 Summary

The results of the intercalibration are summarised in Table 9.1 below:

Table 6.1 - Summary of audited analyser performance – 134 UK stations

Parameter	Number of outliers	Number in network	% outliers in total
NOx analyser	23	115	20 (15)%
CO analyser	0	7	0%
SO_2 analyser	6	30	20 (20)%
Ozone analyser	21	81	26 (28)%
FDMS and BAM analysers	1 k_0, 10 flow, (17 zero)	57 FDMS PM_{10} 2 BAM PM_{10} 69 FDMS $PM_{2.5}$ 2 BAM $PM_{2.5}$	8 (7)%
Gravimetric PM analysers	1 flow	9 PM_{10} 9 $PM_{2.5}$	6%
Total	62	381	16.3%

Four sites were not in operation at the time of the intercalibration. Replacement locations are currently being sought for the sites at Bury Roadside, Chesterfield and Glasgow Centre. The station at Southwark A2 Old Kent Road is currently suspended pending repair of the air conditioning unit.

There are currently no gravimetric measurements of PM_{10} or $PM_{2.5}$ at any of the Glasgow monitoring stations.

The number of analyser outliers identified is worse than the previous exercise. At the Winter 2014 intercalibration 14.5% of the analysers in use were identified as outliers.

The procedures used to determine network performance are documented in Ricardo-AEA Work Instructions. These methods are regularly updated and improved and are evaluated by the United Kingdom Accreditation Service (UKAS). Ricardo-AEA holds ISO17025 accreditation for the on-site calibration of all the analyser types (NOx, CO, SO_2, O_3) and for the determination of the FDMS k_0 factor and particulate analyser flow rates used in the network. An ISO17025 certificate of calibration (Calibration Laboratory number 0401) for the analysers in the AURN is appended to this report.

6.1.2 Network Intercomparisons

The concentration of the audit cylinders was calculated averaged across all monitoring sites using the zero and scaling factors provided by the CMCU on the day of audit. How close the result is to the stated cylinder concentration is a good indication of the accuracy of the provisional results across the entire network. The results are given in Table 9.2. Certified cylinder concentrations are normalised for this purpose as several cylinders are used.

Table 6.2 Audit Cylinder Results

Parameter	Network Mean	Audit reference concentration	Network Accuracy %	%Std Dev
NO	488 ppb	482 ppb	1.3	4.3
NO_2	494 ppb	497 ppb	-0.6	4.7
CO	21.2 ppm	21.3 ppm	-0.4	4.6
SO_2	463 ppb	449 ppb	3.2	4.9

- Oxides of Nitrogen.

  A total of 23 outliers (20%) were identified during this intercalibration. This is worse than the previous exercise - 15% of the analysers were identified as outliers in the winter exercise. Of these outliers, nine can be attributed to analyser drift, seven to changes in site cylinder concentration and five to issues experienced during the audit which compromised the results. There is a multitude of logger types in use at one site (Scunthorpe) which meant that the audit and previous LSO calibrations were recorded using different systems. All of the above outliers can be corrected with no data loss or impact on data quality.

  There was one converter which fell outside the ±5% acceptance limits. There were four further converters identified where the initial result was outside the ±2% trigger for NO_2 rescaling. Additional analysis showed that a total of two outlier converters required rescaling or data deletion to be undertaken.

- Carbon Monoxide

  There were no outliers identified at this intercalibration. No outliers were identified at the previous exercise.

- Sulphur Dioxide

A total of six outliers (20%) were identified at this intercalibration. This is the same as the winter exercise. All m-xylene interference tests were less than 21ppb, compared to 20ppb in winter 2014.

- Ozone

  A total of 21 outliers (26%) were identified during the winter exercise. This is slightly better than the previous intercalibration, where 23 analysers were found to be outside the ±5% acceptance criterion.

- Particulate Analysers

  There was a single calculated k_0 determination outside the required ±2.5% of the stated values. Three outliers were identified at the previous exercise.

  Eight FDMS main flows were found to be outside the ±10% acceptance limits. two BAM total flows were found to be outside this limit. This total is worse than the previous exercise; a total of six analyser flow outliers were identified in the winter.

  A single Partisol analyser total flows was outside the acceptance limits. There were no outliers identified at the winter exercise

- PM analyser zero tests

  A total of 17 analysers (9%) gave average responses to particle-free air that were higher than ±3µg/m^3. This is worse than the previous exercise, where 12 responses were higher than 3µg/m^3. These results will be fed into the ratification process to determine appropriate action.

- Site Cylinder Concentrations

  14 of the 275 site cylinders (5.1%) used to scale ambient pollution data were found to be outside the ±10% acceptance limit, better than the 6.2% identified in the winter.

6.2 London Sites

The results of the intercomparison for the 15 London sites in operation at the time of the intercalibration are summarised below:

Table 6.3 - Summary of audited analyser performance – London Sites

Parameter	Number of outliers	Number in region
NOx analyser	3	12
NOx converter	1	
CO analyser	0	3
SO_2 analyser	0	4
Ozone analyser	4	9
FDMS and BAM analysers	0 k_0, 0 flow (2 zero)	5 FDMS PM_{10} 10 FDMS $PM_{2.5}$
Gravimetric PM analysers	0	2 PM_{10}

		3 $PM_{2.5}$
Cylinders	1	35

6.3 Scottish Sites

The results of the intercomparison for the 18 Scottish sites are summarised below:

Table 6.4 - Summary of audited analyser performance – Scottish Sites

Parameter	Number of outliers	Number in region
NOx analyser	1	14
NOx converter	0	
CO analyser	0	2
SO_2 analyser	0	3
Ozone analyser	1	10
FDMS and BAM analysers	1 k_0, 1 flow (3 zero)	6 FDMS PM_{10} 6 FDMS $PM_{2.5}$
Gravimetric PM analysers	0	4 PM_{10} 4 $PM_{2.5}$
Cylinders	1	33

6.4 Welsh Sites

The results of the intercomparison for the 10 Welsh sites are summarised below:

Table 6.5 - Summary of audited analyser performance – Welsh Sites

Parameter	Number of outliers	Number in region
NOx analyser	2	10
NOx converter	1	
CO analyser	0	2
SO_2 analyser	1	4
Ozone analyser	2	6
FDMS and BAM analysers	0 k_0, 3 flow (1 zero)	5 FDMS PM_{10} 1 BAM PM_{10} 3 FDMS $PM_{2.5}$ 1 BAM $PM_{2.5}$
Gravimetric PM analysers	1	2 PM_{10} 1 $PM_{2.5}$
Cylinders	2	26

6.5 Northern Ireland Sites (incl. Mace Head)

The results of the intercomparison for the five Northern Irish sites and Mace Head are summarised below:

Table 6.6 - Summary of audited analyser performance – Northern Irish Sites

Parameter	Number of outliers	Number in region
NOx analyser	0	3
NOx converter	0	
CO analyser	0	1
SO_2 analyser	1	3
Ozone analyser	0	4
FDMS and BAM analysers	0 k_0, 0 flow (0 zero)	4 FDMS PM_{10} 1 FDMS $PM_{2.5}$
Gravimetric PM analysers	0	0 PM_{10} 0 $PM_{2.5}$
Cylinders	1	9

6.6 English Sites

The results of the intercomparison for the 86 English sites are summarised below:

Table 6.7 - Summary of audited analyser performance – English Sites

Parameter	Number of outliers	Number in region
NOx analyser	17	76
NOx converter	3	
CO analyser	0	1
SO_2 analyser	4	16
Ozone analyser	14	53
FDMS and BAM analysers	0 k_0, 4 flow (11 zero)	37 FDMS PM_{10} 1 BAM PM_{10} 46 FDMS $PM_{2.5}$ 1 BAM $PM_{2.5}$
Gravimetric PM analysers	0	1 PM_{10} 4 $PM_{2.5}$
Cylinders	9	191

As noted earlier, the results from the intercalibration exercises are used to inform the entire data ratification process. Any actions required as a result of the intercalibration findings are discussed in the ratification section of this report.

7 Site Cylinder Concentrations

During the intercalibration, the concentrations of the on-site cylinders were evaluated using the audit cylinder standards. The calculated results showed that 14 of the 275 cylinders (6.1%) used to scale analyser data into concentrations (NO, CO and SO_2) were outside the ±10% acceptance criterion. This is worse than the winter exercise, where 4.3% (12) of the scaling cylinders were outside the acceptance limits. There were 9 NO cylinders identified as outliers.

Of the nine NO cylinders, one appears to have been contaminated (York Fishergate); significant oxidation of the NO into NO_2 has occurred since the last intercalibration. The cylinder has been replaced and the performance of the new cylinder will be closely monitored at subsequent audits.

Two NO cylinders showed significant drift and have been replaced.

Four SO_2 cylinders showed continued drift from the last intercalibration (Derry, Leeds Centre, Nottingham and Wrexham) and have been replaced.

The remaining six NO cylinders and the one SO_2 cylinders will be checked at the next audits and appropriate action taken if necessary.

8 Site Information

All site information is now uploaded to CMCU and UK-Air archive for dissemination using Google Earth. Ricardo-AEA makes considerable effort in ensuring that site locations are accurate on the new Google Earth site information and UK-Air archive pages. All future additions to the AURN will include accurate positioning using Google Earth.

9 CEN

The European Committee for Normalisation (CEN) have prepared a series of documents prescribing how analysers must be operated, to produce datasets that conform to the Data Quality Objectives of the EC Directives. The CEN documents for operation of air pollution analysers; BS EN14211:2005 (NOx), BS EN14212:2005 (SO_2), BS EN14626:2005 (CO) and BS EN14625:2005 (O_3) set out a series of performance criteria for analysers which must be achieved, both in the field and under laboratory conditions. The test requirements have been extensively reported in previous intercalibration summaries and should be referenced for further information.

The CEN operating methodologies are incorporated into the requirements of the air quality Directive 2008/50/EC. Member States had until June 2010 to ensure their monitoring networks are compliant. Older, non-compliant equipment still on site after this date needed to be replaced before June 2013. Ricardo-AEA has taken steps to ensure the procedures used in the UK comply with the requirements ahead of any imposed deadlines. To this end, the procedures used for the intercomparisons have been fully compliant with the CEN protocols since January 2006.

To comply with the Directive, the uncertainty for gaseous analyser measurements must be less than ±15%. For PM analysers, the required measurement uncertainty is less than ±25%. For sites that have CEN-compliant instrumentation, it is possible to calculate the overall uncertainty of measuring air quality. This information is site and analyser specific and presented in the table below:

Table 9.1 – Analyser measurement uncertainties

Date	Site	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
23-Jul	Barnsley Gawber	8.3		11.7	9.8		
10-Jul	Bath Roadside				12.6		
01-Aug	Billingham				11.7		
14-Jul	Birmingham Acocks Green	11.2			12.5		16.4
14-Jul	Birmingham Tyburn	7.4		12.4	13.1	8.8	16.4
15-Jul	Birmingham Tyburn Road	11.2			12.3	8.7	16.4
15-Jul	Blackburn Accrington Rd				11.1		
16-Jul	Blackpool Marton	8.3			9.8		17.5
11-Jul	Bottesford	8.3					
	Bournemouth						
15-Jul	Brighton Preston Park	11.2			11.2		11.0
09-Jul	Bristol St Paul's	11.4			12.5	8.7	16.4
29-Jul	Cambridge Roadside				12.1		
04-Jul	Canterbury	11.2			12.0		
15-Jul	Carlisle Roadside				11.1	8.7	16.4
20-Aug	Charlton Mackrell	10.4			10.9		
03-Jul	Chatham Centre Roadside				13.1	8.7	16.4
	Chesterfield				site	not	online
22-Jul	Chesterfield Roadside				11.1	8.7	16.4
05-Aug	Coventry Allesley	8.3			11.3		16.4
06-Jun	Coventry Memorial Pk	10.7			10.0		
15-Jul	Eastbourne				12.2	8.7	16.4
09-Jul	Exeter Roadside	7.9			13.2		
18-Aug	Glazebury	11.2			12.2		
07-Jul	Great Dun Fell	11.7					
26-Aug	Harwell	11.2		10.0	12.2	8.7	16.4
26-Aug	Harwell Partisol					8.0	11.0
31-Jul	High Muffles	11.2			10.9		
08-Jul	Honiton				12.4		
14-Jul	Horley				18.8		
09-Jul	Hull Freetown	8.3		11.0	11.6		
22-Jul	Ladybower	11.4		8.7	fault		
10-Jul	Leamington Spa	10.4			11.5	10.5	16.4
10-Jul	Leamington Spa Rugby Road				12.2	fault	16.4
09-Jul	Leeds Centre	8.3	8.2	12.8	11.7		
09-Jul	Leeds Headingley Kerbside				12.2		
07-Aug	Leicester University	8.3			9.9		16.4
18-Aug	Leominster	11.2			12.2		
08-Jul	Lincoln Canwick Road				12.5		
03-Jul	Liverpool Queen's Drive Roadside				12.2		
03-Jul	Liverpool Speke	8.3		10.0	11.0	11.1	16.4
21-Aug	Lullington Heath	11.2		8.7	11.0		
19-Aug	Manchester Piccadilly	8.3		10.0	12.2	9.3	16.4
19-Aug	Manchester South			10.1	12.2		
07-Aug	Market Harborough	8.6			9.8		
01-Aug	Middlesbrough	11.2		10.7	11.3	8.7	16.4
30-Jul	Newcastle Centre	8.3			10.4	8.7	16.4
30-Jul	Newcastle Cradlewell Roadside				11.2		
06-Aug	Northampton Kingsthorpe	7.3			13.7		11.0

Date	Site	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
30-Jul	Norwich Lakenfields	8.3			9.9	8.7	16.4
09-Jul	Nottingham Centre	8.3		8.9	9.8	8.7	16.4
26-Aug	Oxford Centre Roadside				13.1		
26-Aug	Oxford St Ebbes	10.4			11.9	8.7	16.4
08-Jul	Plymouth Centre	8.3			9.9	8.7	16.4
28-Aug	Portsmouth	8.3			13.0	19.4	16.4
03-Sep	Preston				9.8		16.4
29-Aug	Reading New Town	8.3			11.1	8.7	16.4
03-Jul	Rochester Stoke			10.1	17.0	8.7	16.4
20-Aug	Salford Eccles	10.4			11.1	9.4	16.4
	Saltash Callington Road						
28-Jul	Sandy Roadside				12.4	12.3	16.4
08-Jul	Scunthorpe Town			4.1	11.4	8.7	
21-Aug	Shaw Crompton Way				12.2	9.3	
21-Jul	Sheffield Devonshire Grn	8.3			11.3		
21-Jul	Sheffield Tinsley				11.0		
11-Sep	Sibton	11.2					
12-Aug	Southampton Centre	8.3		10.3	9.8	8.7	16.4
01-Jul	Southend-on-Sea	8.3			9.8		16.4
01-Jul	St Osyth	8.3			9.8		
30-Jun	Stanford-le-Hope Road				12.4	8.7	16.4
31-Jul	Stockton-on-Tees Eaglescliffe				12.2	9.3	12.6
30-Jun	Stoke-on-Trent Centre				12.2	8.7	16.4
16-Jul	Storrington Roadside				11.5	15.3	16.4
29-Jul	Sunderland Silksworth	11.2			12.1		16.4
30-Jun	Thurrock	11.2		10.0	12.2	8.7	
16-Jul	Walsall Woodlands	12.4			12.4		
02-Jul	Warrington			9.8	11.1	8.7	16.4
31-Jul	Weybourne	8.4					
29-Jul	Wicken Fen	11.2		10.0	11.1		
20-Aug	Wigan Centre	8.3			11.3		16.4
01-Jul	Wirral Tranmere	8.3			10.7		16.4
19-Aug	Yarner Wood	11.2			10.9		
23-Jul	York Bootham					8.7	16.4
08-Jul	York Fishergate				11.8		
13-Aug	Camden Kerbside				16.7	8.7	16.4
22-Jul	Ealing Horn Lane					8.7	
11-Aug	Haringey Roadside				16.1		16.4
05-Aug	London Bexley			10.1	18.4		16.4
06-Aug	London Bloomsbury	11.2		10.0	12.4	11.2	16.4
21-Jul	London Eltham	10.4			12.2		16.4
11-Aug	London Haringey Priory Park South	10.4			15.2		
31-Jul	London Harlington	13.2			12.2	8.7	16.4
13-Aug	London Harrow Stanmore						16.4
31-Jul	London Hillingdon	9.8			14.3		
24-Jul	London Marylebone Rd			10.0	12.2	8.7	16.4
24-Jul	London Marylebone Road Partisol					8.0	11.0
22-Jul	London N. Kensington	11.2	7.5	10.0	12.8	8.7	16.4
22-Jul	London N. Kensington Partisol					8.0	11.0
14-Aug	London Teddington	11.2			13.0		
14-Aug	London Teddington Bushy Park					8.7	
30-Jul	London Westminster				11.3		11.0

Date	Site	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
	Southwark A2 OKR						
07-Aug	Tower Hamlets Roadside				11.5		
28-Aug	Armagh Roadside				11.5	8.7	
25-Aug	Ballymena Ballykeel			9.9			
29-Aug	Belfast Centre	8.3	7.5	10.3	9.8	8.7	16.4
20-Aug	Derry	11.2		10.6	12.6	9.8	16.4
18-Aug	Lough Navar	11.2				8.7	
18-Aug	Mace Head	N/A					
13-Aug	Aberdeen	11.2			10.9	8.7	16.4
14-Aug	Aberdeen Union Street Roadside				12.2		
06-Aug	Auchencorth Moss	11.2				10.1	16.4
06-Aug	Auchencorth Moss Partisol					12.0	11.0
06-Aug	Bush Estate	11.2			13.0		
24-Jul	Dumbarton Roadside				12.6		
14-Jul	Dumfries				10.9		
07-Jul	Edinburgh St Leonards	11.5	8.8	10.1	17.0	8.7	16.4
14-Jul	Eskdalemuir	11.2			12.2		
23-Jul	Fort William				12.4		
21-Jul	Glasgow Kerbside				10.5	8.7	16.4
21-Jul	Glasgow Townhead	8.3			11.0	11.4	16.4
04-Aug	Grangemouth			10.7	11.7	8.7	16.4
04-Aug	Grangemouth Moray				11.3		
14-Aug	Inverness				10.9	8.0	11.0
05-Aug	Peebles	11.2			12.2		
14-Aug	Strath Vaich	11.2					
18-Aug	Aston Hill	11.2			12.3		
24-Jul	Cardiff Centre	11.2		10.2	13.3	8.7	16.4
21-Jul	Chepstow A48				14.7	8.7	16.4
24-Jul	Cwmbran				13.0		
22-Jul	Narberth			10.0	11.2	8.7	
23-Jul	Newport				11.7	8.7	16.4
23-Jul	Port Talbot Margam	8.3	11.5	11.6	11.3	8.7	16.4
23-Jul	Port Talbot Margam Partisol					8.0	11.0
22-Jul	Swansea Roadside				12.5	41.7	41.1
01-Jul	Wrexham			9.7	10.9	8.0	11.0

This table is updated and extended after every intercalibration to include upgraded sites and replacement analysers.

The poor measurement uncertainty reported for the NOx analysers at Camden Kerbside, Haringey Roadside, Horley, London Bexley, London Haringey Priory Park South and Edinburgh St Leonards were all due to significant instrument noise recorded during the audit

The PM analysers at Swansea Roadside again arose as a result of the very low measured instrument flow rates at the audit. The significance of this will be examined fully during ratification.

The ozone analyser at Mace Head is not a CEN compliant model and therefore no generic performance data have been calculated.

10 Certification

The Network Certificate of Calibration is presented in Appendix 1. This certificate presents the results of the individual analyser scaling factors on the day of the audit, as calculated by Ricardo-AEA using the audit cylinder standards, in accordance with our ISO17025 accreditation

Appendices

Appendix 1: Certificate of Calibration

Appendix 1 – Certificate of Calibration

CERTIFICATE OF CALIBRATION

RICARDO-AEA

0401

Ricardo-AEA, Gemini, Fermi Avenue Harwell, Didcot,
Oxfordshire OX11 0QJ
Telephone 01235 753212

Certificate Number: 03064
Ricardo-AEA Calibration ID Number: ED57002030

Authorised Signatories: S Eaton
B Stacey

Signed:

Date of Issue: 26 February 2015

Customer Name and Address: John Newington
Atmosphere and Noise
Resource, Atmosphere and Sustainability
Department for Environment, Food and Rural Affairs
Area 2C Nobel House, 17 Smith Square, London, SW1P 3JR

Date of Calibration: July to September 2014

Description: Calibration factors for monitoring stations in the UK Automatic Urban and Rural Monitoring Network

The reported expanded uncertainties are based on a standard uncertainty multiplied by a coverage factor k=2 providing a level of confidence of approximately 95% The uncertainty evaluation has been carried out in accordance with UKAS requirements.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory

CERTIFICATE OF CALIBRATION

0401

Certificate Number: 03064
Ricardo-AEA Calibration ID Number: ED57002030

1. Carbon Monoxide

Site	Date Year = 2014	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*Maximum Residual (%)
English Sites							
Leeds Centre	09-Jul	458	0.8	0.2	1.030	3.3	3.3
London Sites							
London Marylebone Road	24-Jul	10073	0.9	0.2	1.000	2.2	1.5
London N. Kensington	22-Jul	2313	0.3	0.2	1.056	2.2	1.1
Northern Irish Sites							
Belfast Centre	29-Aug	462	0.20	0.20	1.1152	2.3	0.8
Scottish Sites							
Edinburgh St Leonards	07-Jul	159	0.10	0.20	1.0503	2.4	4.2
Welsh Sites							
Cardiff Centre	24-Jul	12599	0.9	0.2	1.040	2.1	1.8
Port Talbot Margam	23-Jul	605214618	2.1	0.2	0.968	2.2	1.2

2. Sulphur Dioxide

Site	Date Year =2014	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)	*m-xylene interference (ppb)
English Sites								
Barnsley Gawber	23-Jul	08050082	5.1	2.5	0.906	3.5	2.4	-1.0
Birmingham Tyburn	14-Jul	EH937000	3.8	2.5	0.941	3.1	0.5	0.6
Harwell	26-Aug	83	4.3	2.5	0.931	3.1	0.3	9.7
Hull Freetown	09-Jul	342	2.8	2.5	0.886	3.6	4.1	3.7
Ladybower	22-Jul	1178	3.5	2.5	0.997	3.3	0.6	4.0
Leamington Spa	10-Jul	Analyser	not	present				
Leeds Centre	09-Jul	08050084	0.3	2.5	0.908	4.1	5.0	6.1
Liverpool Speke	03-Jul	17509	1.8	2.5	0.951	3.1	0.5	10.2
Lullington Heath	21-Aug	1179	5.1	2.5	0.914	3.2	0.4	10.7
Manchester Piccadilly	19-Aug	19216	-0.2	2.5	1.050	3.1	0.4	6.0
Middlesbrough	01-Aug	345	-1.6	2.7	1.335	3.7	3.6	6.4
Nottingham Centre	09-Jul	1629	-1.8	2.4	0.810	3.2	2.1	10.4
Rochester Stoke	03-Jul	2800	16.0	2.7	0.808	3.2	1.8	9.7
Scunthorpe Town	08-Jul	635b-258	-1.0	2.7	1.329	3.4	0.9	10.6
Southampton Centre	12-Aug	343	22.2	2.5	0.924	3.2	2.6	3.0
Thurrock	30-Jun	189	7.2	2.5	0.956	3.3	1.7	2.1
Wicken Fen	29-Jul	73	1.1	2.5	0.960	3.1	1.0	6.3
London Sites								
London Bexley	05-Aug	318	35.4	3.1	0.926	3.4	1.3	16.1
London Bloomsbury	06-Aug	74	1.2	2.5	0.936	3.1	0.1	9.6
London Marylebone Road	24-Jul	19220	1.3	2.5	1.036	3.2	0.1	11.3
London N. Kensington	22-Jul	2576	15.2	2.5	0.947	3.1	1.1	11.3
Northern Irish Sites								
Ballymena Ballykeel	25-Aug	4901234	3.0	2.7	0.931	3.4	1.1	14.0
Belfast Centre	29-Aug	1766	4.7	2.5	1.010	3.5	2.5	8.6
Derry	20-Aug	1697	-5.7	2.4	0.680	4.2	3.3	3.8
Scottish Sites								
Edinburgh St Leonards	07-Jul	84	5.4	2.5	0.922	3.3	2.1	11.8
Grangemouth	04-Aug	1211322	1.0	2.5	0.855	4.0	3.9	21.4

CERTIFICATE OF CALIBRATION

0401

Certificate Number: 03064
Ricardo-AEA Calibration ID Number: ED57002030

Site	Date Year =2014	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)	*m-xylene interference (ppb)
Welsh Sites								
Cardiff Centre	24-Jul	14319	30.6	2.5	0.968	3.2	2.3	3.1
Narberth	22-Jul	14896	5.7	2.6	1.131	3.1	0.6	8.1
Port Talbot Margam	23-Jul	605214617	2.6	2.5	1.014	3.3	1.5	0.8
Wrexham	01-Jul	1181	23.3	2.4	0.736	3.6	3.9	16.1

3. Ozone

Site	Date Year =2014	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)
English Sites							
Barnsley Gawber	23-Jul	cm08060030	0.5	3	0.986	3.1	0.4
Birmingham Acocks Green	14-Jul	2435	-2.4	3	1.025	3.1	0.4
Birmingham Tyburn	14-Jul	WB6AG7TM	0.5	3	0.810	3.1	1.3
Birmingham Tyburn Roadside	15-Jul	2434	0.3	3	1.040	3.1	0.3
Blackpool Marton	16-Jul	CM08060037	0.2	3	1.030	3.1	0.0
Bottesford	11-Jul	CM08060022	-0.2	3	0.962	3.1	1.3
Bournemouth		Not Audited					
Brighton Preston Park	15-Jul	12461	5.3	3	0.925	3.2	1.0
Bristol St Paul's	09-Jul	155	-0.7	3	1.019	3.1	2.4
Canterbury	04-Jul	2448	7.6	3	0.891	3.1	0.5
Charlton Mackrell	20-Aug	1111957	0.5	3	0.993	3.1	0.2
Coventry Memorial Park	06-Jun	CM08060044	0.2	3	1.016	3.2	1.7
Exeter Roadside	09-Jul	F0100E0S	-3.2	3	0.768	3.5	2.8
Glazebury	18-Aug	19751	1.2	3	0.998	3.1	0.6
Great Dun Fell	07-Jul	1647	1.5	3	1.005	3.1	3.5
Harwell	26-Aug	1648	-1.1	3	1.008	3.1	0.7
High Muffles	31-Jul	1641	0.5	3	0.9676	3.1	1.6
Hull Freetown	09-Jul	cm68060045	0.3	3	0.988	3.0	0.5
Ladybower	22-Jul	1651	-1.0	3	0.957	3.1	2.5
Leamington Spa	10-Jul	411770	0.5	3	0.981	3.1	0.8
Leeds Centre	09-Jul	080060036	-1.2	3	0.925	3.0	0.2
Leicester University	07-Aug	CM08060020	-0.1	3	1.133	3.6	0.3
Leominster	18-Aug	170	2.4	3	1.007	3.1	0.4
Liverpool Speke	03-Jul	cm08060041	0.2	3	1.016	3.1	0.1
Lullington Heath	21-Aug	1644	-0.7	3	1.005	3.1	0.2
Manchester Piccadilly	19-Aug	0	-0.1	3	1.065	3.1	0.3
Manchester South	19-Aug	16954	-0.8	3	1.037	3.1	0.5
Market Harborough	07-Aug	CM08060031	1.5	3	1.083	3.7	2.5
Middlesbrough	01-Aug	2436	0.2	3	1.008	3.1	1.4
Newcastle Centre	30-Jul	8060033	0.4	3	0.985	3.1	0.5
Northampton Kingsthorpe	06-Aug	47R76STR	0.1	3	0.840	3.6	0.8
Norwich Lakenfields	30-Jul	CM08060028	0.5	3	1.083	3.6	0.4
Nottingham Centre	09-Jul	CM08060032	0.1	3	0.980	3.1	1.1
Plymouth Centre	08-Jul	CM08060027	0.5	3	0.985	3.2	0.9
Portsmouth	28-Aug	CM08060023	-1.1	3	0.963	3.1	0.6
Preston	03-Sep	CM08060042	-0.6	3	1.007	3.1	0.8
Reading New Town	29-Aug	CM08060025	-0.2	3	0.997	3.2	1.5
Rochester Stoke	03-Jul	378	-1.0	3	1.013	3.1	0.8
Salford Eccles	20-Aug	1111596	0.0	3	1.020	3.4	1.5
Sheffield Devonshire Green	21-Jul	cm08060024	0.7	3	0.968	3.1	0.8
Sibton	11-Sep	146	0.4	3	1.035	3.1	0.6
Southampton Centre	12-Aug	cm08060021	-0.1	3	1.021	3.1	0.4
Southend-on-Sea	01-Jul	CM08060017	0.1	3	1.030	3.1	0.1

CERTIFICATE OF CALIBRATION

0401

Certificate Number: 03064
Ricardo-AEA Calibration ID Number: ED57002030

Site	Date Year =2014	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)
St Osyth	01-Jul	CM08060035	0.2	3	0.992	3.1	1.0
Stoke-on-Trent Centre	30-Jun	CM08060026	-0.5	3	1.187	3.2	1.6
Sunderland Silksworth	29-Jul	436	0.7	3	0.990	3.1	0.4
Thurrock	30-Jun	221	0.2	3	1.135	3.1	0.8
Walsall Woodlands	16-Jul	2431	7.4	3	1.032	3.2	4.8
Weybourne	31-Jul	CM10180038	-0.6	3	1.048	3.7	1.5
Wicken Fen	29-Jul	165	-1.3	3	1.063	3.6	0.7
Wigan Centre	20-Aug	CM08060018	-1.8	3	0.939	3.1	0.4
Wirral Tranmere	01-Jul	CM08060040	-0.2	3	1.016	3.1	0.8
Yarner Wood	19-Aug	2437	-1.3	3	1.007	3.1	0.8
London Sites							
London Bloomsbury	06-Aug	435	-0.5	3	1.024	3.2	0.6
London Eltham	21-Jul	1111958	analyser	fault			
London Haringey Priory Park South	11-Aug	1111953	0.3	3	0.874	3.1	0.4
London Harlington	31-Jul	14309	1.5	3	1.313	7.3	3.2
London Hillingdon	31-Jul	8060034	1.0	3	1.213	3.8	4.9
London Marylebone Road	24-Jul	19223	7.3	3	1.053	3.2	0.2
London N. Kensington	22-Jul	2372	0.1	3	0.979	3.1	0.3
London Teddington	14-Aug	2447	0.4	3	1.068	3.1	0.4
London Westminster							
Northern Ireland Sites (plus Mace Head)							
Belfast Centre	29-Aug	cm08060038	0.4	3	1.020	3.1	0.5
Derry	20-Aug	1586	-3.3	3	1.040	3.1	0.8
Lough Navar	18-Aug	1640	1.1	3	1.032	3.1	0.6
Mace Head	18-Aug	77086-385	0.3	3	1.005	3.1	2.4
Scottish Sites							
Aberdeen	13-Aug	800	0.6	3	1.000	3.1	1.3
Auchencorth Moss	06-Aug	1646	0.0	3	1.017	3.0	0.6
Bush Estate	06-Aug	1645	0.2	3	0.998	3.1	1.2
Edinburgh St Leonards	07-Jul	136	-2.0	3	1.049	3.1	2.8
Eskdalemuir	14-Jul	158	1.0	3	1.044	3.1	0.4
Fort William	23-Jul	1023	-0.4	3	1.002	3.1	0.5
Glasgow Townhead	21-Jul	8060029	0.0	3	0.968	3.1	1.1
Lerwick			site	not	operational		
Peebles	05-Aug	2449	audit	photometer	fault		
Strath Vaich	14-Aug	176	-0.5	3	1.072	3.0	0.9
Welsh Sites							
Aston Hill	18-Aug	144	-0.2	3	1.086	3.1	1.0
Cardiff Centre	24-Jul	14348	-2.3	3	1.047	3.6	0.3
Cwmbran	24-Jul		1.8	3	0.995	3.7	2.3
Narberth	22-Jul	10280	0.1	3	1.558	3.7	1.6
Port Talbot Margam	23-Jul	CM10140049	-0.1	3	0.953	3.1	1.4

Certificate Number: 03064
Ricardo-AEA Calibration ID Number: ED57002030

4. Oxides of Nitrogen

Site	Date Year =2014	Analyser number		[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
English Sites									
Barnsley Gawber	23-Jul	08050057	NOx NO	-2.5 0.2	2.5 2.5	0.961 0.952	3.5 3.5	0.6 0.6	100.7
Bath Roadside	10-Jul	1957	NOx NO	-21.6 -20.7	3.3 2.7	1.281 1.299	3.5 3.5	2.8 3.2	99.7
Billingham	01-Aug	574	NOx NO	-0.1 -0.4	2.4 2.5	0.790 0.902	3.5 3.6	3.6 3.0	99.7
Birmingham Acocks Green	14-Jul	3364	NOx NO	2.8 0.2	2.9 2.7	1.308 1.312	3.5 3.5	0.7 0.8	99.2
Birmingham Tyburn	14-Jul	Y7ACC7MC	NOx NO	1.4 -0.9	2.5 2.6	0.981 0.994	3.5 3.5	0.9 0.9	98.3
Birmingham Tyburn Roadside	15-Jul	68	NOx NO	1.3 0.1	3.0 2.9	1.678 1.692	3.5 3.5	0.2 0.2	98.3
Blackburn Darwen Roadside					Site	not	operational		
Blackpool Marton	16-Jul	08050075	NOx NO	1.2 1.1	2.5 2.5	0.937 0.984	3.5 3.5	0.6 0.6	100.5
Bournemouth					Site	not	audited		
Brighton Preston Park	15-Jul	13068	NOx NO	3.8 3.0	2.6 2.6	1.106 1.109	3.5 3.5	2.2 1.7	98.9
Bristol St Paul's	09-Jul	77	NOx NO	1.4 0.7	2.8 2.7	1.340 1.347	3.5 3.5	1.9 1.4	98.5
Cambridge Roadside	29-Jul	1011843	NOx NO	2.0 0.0	2.9 2.7	1.345 1.331	3.5 3.5	0.9 1.7	107.1
Canterbury	04-Jul	1147	NOx NO	1.9 1.8	2.9 2.7	1.162 1.172	3.5 3.5	2.7 2.6	99.9
Carlisle Roadside	15-Jul	1011849	NOx NO	2.0 -1.0	2.5 2.5	1.036 1.028	3.5 3.5	0.7 0.9	98.3
Charlton Mackrell	20-Aug	2120	NOx NO	-2.2 0.2	2.6 2.6	1.119 1.140	3.5 3.5	0.5 0.7	97.9
Chatham Centre Roadside	03-Jul	3393	NOx NO	1.2 0.7	2.9 2.6	1.201 1.199	3.5 3.5	2.4 1.5	99.0
Chesterfield					Site	not	operational		
Chesterfield Roadside	22-Jul	1011835	NOx NO	2.0 -2.0	2.6 2.8	1.159 1.128	3.5 3.5	0.6 0.2	99.1
Coventry Memorial Park	06-Jun	08030109	NOx NO	-0.3 0.0	2.4 2.4	0.766 0.755	3.5 3.5	0.4 0.3	98.4
Eastbourne	15-Jul	19209	NOx NO	0.1 0.5	2.6 2.6	1.174 1.160	3.5 3.5	0.7 0.5	99.0
Exeter Roadside	09-Jul	G0000D1S	NOx NO	-0.2 0.2	2.5 2.6	0.997 1.026	3.5 3.5	1.9 2.2	98.6
Glazebury	18-Aug	14354	NOx NO	-0.9 -1.7	2.9 2.9	1.694 1.728	3.5 3.5	0.6 1.3	98.4
Harwell	26-Aug	79	NOx NO	1.9 1.7	2.6 2.6	1.253 1.259	3.5 3.5	1.0 0.9	99.0
High Muffles	31-Jul	1783	NOx NO	0.7 0.8	2.6 2.6	1.258 1.233	3.5 3.5	0.5 0.3	98.5
Honiton	08-Jul	3392	NOx NO	2.2 2.3	2.7 3.2	1.347 1.332	3.5 3.5	1.9 2.2	99.6
Horley	14-Jul	1401954	NOx	9.0	3.6	1.087	3.5	0.5	99.6

CERTIFICATE OF CALIBRATION

0401

Certificate Number: 03064
Ricardo-AEA Calibration ID Number: ED57002030

Site	Date Year =2014	Analyser number		[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
			NO	0.0	2.7	1.050	3.5	1.1	
Hull Freetown	09-Jul	1882	NOx	-0.1	2.6	1.175	4.1	3.3	100.8
			NO	-0.1	2.6	1.170	4.1	3.2	
Ladybower	22-Jul		NOx		Analyser	not	operational		
			NO						
Leamington Spa	10-Jul	1011842	NOx	4.0	2.7	1.121	3.5	0.6	98.0
			NO	-1.0	2.8	1.124	3.5	1.0	
Leamington Spa Rugby Road	10-Jul	3365	NOx	-0.2	2.6	1.069	3.5	0.4	98.7
			NO	0.7	2.5	1.032	3.5	1.3	
Leeds Centre	09-Jul	08050066	NOx	-1.0	2.4	0.755	3.5	3.0	101.6
			NO	0.8	2.4	0.754	3.5	3.4	
Leeds Headingley Kerbside	09-Jul	342	NOx	-0.3	2.6	1.233	3.5	1.2	98.6
			NO	-2.3	2.6	1.209	3.5	1.2	
Leicester University	07-Aug	08050021	NOx	8.4	2.6	1.151	3.5	1.8	98.1
			NO	9.2	2.6	1.085	3.5	1.7	
Leominster	18-Aug	346	NOx	-4.9		1.152	Analyser	leak	failed
			NO	-1.3		1.143			
Lincoln Canwick Road	08-Jul	3394	NOx	1.0	2.6	1.111	3.5	2.4	98.2
			NO	0.8	2.6	1.112	3.5	1.0	
Liverpool Queen's Drive Roadside	03-Jul	16927	NOx	1.0	2.6	1.227	3.5	0.2	99.5
			NO	-0.4	2.6	1.226	3.5	0.6	
Liverpool Speke	03-Jul	08050069	NOx	0.6	2.5	1.006	3.7	4.5	98.7
			NO	0.1	2.5	1.023	3.6	4.1	
Lullington Heath	21-Aug	2579	NOx	-0.2	2.7	1.341	3.5	1.1	98.1
			NO	1.0	2.7	1.332	3.5	0.5	
Manchester Piccadilly	19-Aug	21278	NOx	1.7	2.5	0.953	3.5	0.5	98.6
			NO	0.0	2.5	0.932	3.5	0.6	
Manchester South	19-Aug	17311	NOx	1.5	2.5	1.015	3.5	0.8	99.8
			NO	0.9	2.5	1.021	3.5	0.6	
Market Harborough	07-Aug	08050068	NOx	1.2	2.4	0.549	3.5	1.1	100.0
			NO	0.9	2.4	0.497	3.5	1.2	
Middlesbrough	01-Aug	2287	NOx	-3.2	2.6	1.178	3.6	2.6	99.1
			NO	-3.4	2.6	1.169	3.8	2.9	
Newcastle Centre	30-Jul	8050063	NOx	-0.4	2.5	1.042	3.7	3.4	100.4
			NO	-0.2	2.5	1.030	3.6	3.0	
Newcastle Cradlewell Roadside	30-Jul	1011853	NOx	-1.0	2.5	0.888	3.5	1.3	98.4
			NO	0.0	2.5	0.875	3.5	1.4	
Northampton Kingsthorpe	06-Aug	8ATJ6APR	NOx	1.2	2.8	0.996	3.5	0.6	99.8
			NO	-0.4	2.6	1.004	3.5	0.5	
Norwich Lakenfields	30-Jul	08050067	NOx	0.5	2.5	1.066	3.5	0.5	99.6
			NO	0.3	2.5	1.071	3.5	0.7	
Nottingham Centre	09-Jul	08050072	NOx	0.7	2.5	0.945	3.5	1.5	99.2
			NO	-0.3	2.5	0.943	3.5	1.4	
Oxford Centre Roadside	26-Aug	1011844	NOx	3.0	2.8	1.345	3.5	1.1	99.4
			NO	-1.0	2.9	1.331	3.5	1.6	
Oxford St Ebbes	26-Aug	1011830	NOx	1.0	2.6	1.164	3.5	1.2	99.0
			NO	-1.0	2.6	1.155	3.5	0.6	
Plymouth Centre	08-Jul	08050062	NOx	-0.2	2.5	0.903	3.5	1.8	99.3
			NO	1.0	2.5	0.891	3.5	1.7	
Portsmouth	28-Aug	P0T7CYA5	NOx	-0.3	2.5	0.985	3.5	0.4	99.6
			NO	-1.0	2.7	1.006	3.5	0.3	

CERTIFICATE OF CALIBRATION

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Certificate Number: 03064
Ricardo-AEA Calibration ID Number: ED57002030

Site	Date Year =2014	Analyser number		[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
Preston	03-Sep	08050664	NOx	0.2	2.5	0.964	3.5	0.3	98.9
			NO	0.4	2.5	0.964	3.5	0.5	
Reading New Town	29-Aug	08050059	NOx	0.0	2.5	0.895	3.5	0.8	99.0
			NO	0.3	2.5	0.887	3.5	0.9	
Rochester Stoke	03-Jul	3095	NOx	1.0	2.6	1.265	3.6	2.3	99.5
			NO	1.0	2.9	1.257	3.5	2.1	
Salford Eccles	20-Aug	1011831	NOx	4.0	2.5	0.987	3.5	0.4	99.1
			NO	-1.0	2.5	0.980	3.5	0.2	
Sandy Roadside	28-Jul	2585	NOx	6.1	2.6	0.979	3.5	0.9	99.4
			NO	0.7	2.5	1.000	3.5	0.8	
Scunthorpe Town	08-Jul	1011847	NOx	12.0	2.6	1.073	3.5	0.9	100.0
			NO	0.0	2.6	1.049	3.5	0.5	
Shaw Crompton Way	21-Aug	20861	NOx	-4.2	2.5	1.054	3.5	0.4	99.2
			NO	-0.4	2.5	1.058	3.5	1.2	
Sheffield Devonshire Green	21-Jul	08050055	NOx	1.4	2.5	0.993	4.9	1.5	100.4
			NO	1.2	2.5	1.042	4.0	5.3	
Sheffield Tinsley	21-Jul	571	NOx	5.7	2.6	1.098	3.5	0.5	96.4
			NO	5.7	2.6	1.089	3.5	0.9	
Southampton Centre	12-Aug	08030106	NOx	1.3	2.5	0.911	3.5	1.6	98.1
			NO	1.0	2.5	0.908	3.5	1.6	
Southend-on-Sea	01-Jul	08050071	NOx	0.5	2.5	1.015	3.5	0.7	99.2
			NO	0.4	2.5	1.015	3.5	0.8	
St Osyth	01-Jul	08050073	NOx	-2.8	2.5	0.902	3.5	0.1	100.7
			NO	-2.3	2.5	0.907	3.5	0.3	
Stanford-le-Hope Roadside	30-Jun	191	NOx	2.9	2.6	1.165	3.5	1.2	99.1
			NO	1.0	2.6	1.172	3.5	0.9	
Stockton-on-Tees Eaglescliffe	31-Jul		NOx	0.4	2.7	1.355	3.5	0.8	100.5
			NO	0.9	2.7	1.353	3.5	0.4	
Stoke-on-Trent Centre	30-Jun	08050070	NOx	-2.1	2.5	1.013	3.5	0.5	100.0
			NO	-2.3	2.5	1.004	3.5	0.4	
Storrington Roadside	16-Jul	12190	NOx	-8.6	2.7	1.205	3.5	2.8	98.4
			NO	-2.2	2.6	1.229	3.5	1.9	
Sunderland Silksworth	29-Jul	1011854	NOx	2.0	2.8	1.150	3.5	3.2	100.7
			NO	-1.0	2.6	1.139	3.5	3.6	
Thurrock	30-Jun	192	NOx	1.2	2.6	1.087	3.5	0.8	99.6
			NO	0.7	2.6	1.096	3.5	0.9	
Walsall Woodlands	16-Jul	3391	NOx	2.5	2.7	1.306	3.5	2.0	98.9
			NO	0.7	2.7	1.316	3.5	1.2	
Warrington	02-Jul	1011826	NOx	9.0	2.5	1.056	3.5	0.2	98.1
			NO	0.0	2.5	1.032	3.5	0.5	
Wicken Fen	29-Jul	2223	NOx	2.5	2.6	1.179	3.5	1.9	96.3
			NO	2.5	2.6	1.190	3.5	2.0	
Wigan Centre	20-Aug	1011832	NOx	2.0	2.6	1.038	3.5	0.6	100.5
			NO	-1.0	2.5	1.035	3.5	0.7	
Wirral Tranmere	01-Jul	08050060	NOx	1.1	2.5	1.044	3.5	1.4	99.2
			NO	0.8	2.5	1.050	3.5	1.3	
Yarner Wood	19-Aug	1784	NOx	0.9	2.5	1.037	3.5	0.7	98.1
			NO	-0.1	2.5	1.041	3.5	0.6	
York Fishergate	08-Jul	1011848	NOx	1.0	2.9	1.205	3.5	1.2	98.6
			NO	-1.0	2.6	1.193	3.5	1.2	

CERTIFICATE OF CALIBRATION

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Site	Date Year =2014	Analyser number		[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
London Sites									
Camden Kerbside	13-Aug	1011846	NOx	3.0	4.3	1.025	3.5	0.6	101.2
			NO	0.0	2.6	1.023	3.5	0.5	
Haringey Roadside	11-Aug	1011827	NOx	6.0	3.5	1.004	3.5	0.3	100.0
			NO	0.0	2.6	0.987	3.5	0.7	
London Bexley	05-Aug	327	NOx	4.1	2.7	1.136	3.6	1.5	100.6
			NO	0.2	2.5	1.019	3.5	0.4	
London Bloomsbury	06-Aug	74	NOx	-10.6	2.6	0.965	3.5	1.1	98.3
			NO	0.2	2.5	1.006	3.5	0.2	
London Eltham	21-Jul	1011834	NOx	4.0	3.0	1.086	3.5	0.8	100.8
			NO	0.0	2.6	1.066	3.5	0.6	
London Haringey Priory Park South	11-Aug	1084	NOx	0.2	3.3	1.022	3.5	1.8	98.2
			NO	0.1	2.6	1.026	3.5	2.2	
London Harlington	31-Jul	21123	NOx	3.1	2.5	1.042	3.5	0.6	97.0
			NO	0.4	2.5	1.049	3.5	1.6	
London Hillingdon	31-Jul	8050017	NOx	6.8	2.5	0.949	3.5	0.2	99.2
			NO	7.1	2.5	0.948	3.5	0.4	
London Marylebone Road	24-Jul	19210	NOx	3.5	2.6	1.194	3.5	0.2	100.0
			NO	1.2	2.6	1.196	3.5	0.7	
London N. Kensington	22-Jul	3273	NOx	4.1	2.8	1.096	3.5	1.3	99.7
			NO	3.8	2.5	1.051	3.5	2.7	
London Teddington	14-Aug	3406	NOx	2.0	3.4	1.538	3.5	1.0	98.2
			NO	0.6	2.8	1.517	3.5	1.0	
London Westminster	30-Jul	573	NOx	4.0	2.8	1.634	3.5	2.5	99.3
			NO	2.4	2.7	1.450	3.5	0.5	
Southwark A2 Old Kent Road					Site	not	operational		
Tower Hamlets Roadside	07-Aug	1011838	NOx	1.0	2.7	1.110	3.5	0.2	99.1
			NO	-1.0	2.7	1.102	3.5	1.0	
Northern Irish Sites									
Armagh Roadside	28-Aug	1011845	NOx	4.0	2.6	1.108	3.5	1.0	98.5
			NO	0.0	2.8	1.100	3.5	1.7	
Belfast Centre	29-Aug	08050074	NOx	-0.1	2.6	1.118	3.5	0.5	98.7
			NO	-0.2	2.6	1.109	3.5	0.5	
Derry	20-Aug	2130	NOx	3.7	2.8	1.074	3.5	0.4	98.8
			NO	-0.2	2.6	1.053	3.5	0.6	
Scottish Sites									
Aberdeen	13-Aug	519	NOx	0.0	2.8	1.500	3.5	0.6	100.6
			NO	0.0	2.8	1.480	3.5	0.5	
Aberdeen Union Street Roadside	14-Aug	299	NOx	2.3	2.7	1.446	3.5	0.2	99.0
			NO	1.0	2.7	1.426	3.5	0.4	
Bush Estate	06-Aug	2244	NOx	4.2	2.8	0.949	3.5	0.9	100.7
			NO	1.4	2.5	0.987	3.5	1.0	
Dumbarton Roadside	24-Jul	1411835	NOx	1.0	2.8	1.172	3.5	2.7	101.0
			NO	0.0	2.6	1.170	3.5	2.5	
Dumfries	14-Jul	1494	NOx	0.5	2.6	1.172	3.5	0.8	95.2
			NO	0.6	2.6	1.156	3.5	0.9	
Edinburgh St Leonards	07-Jul	73	NOx	-0.5	3.0	1.877	3.5	0.8	99.3
			NO	-1.4	3.0	1.855	3.7	2.0	
Eskdalemuir	14-Jul	347	NOx	2.3	2.5	0.929	3.5	0.7	98.3
			NO	2.0	2.5	0.921	3.5	0.6	

CERTIFICATE OF CALIBRATION

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Certificate Number: 03064
Ricardo-AEA Calibration ID Number: ED57002030

Site	Date Year =2014	Analyser number		[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
Fort William	23-Jul	344	NOx	-0.3	2.5	1.014	3.5	2.1	100.4
			NO	-0.6	2.5	1.018	3.5	1.9	
Glasgow Kerbside	21-Jul	8050061	NOx	-2.0	2.5	0.964	4.1	3.4	99.7
			NO	-2.4	2.5	0.959	3.5	2.2	
Glasgow Townhead	21-Jul	1713	NOx	0.3	2.6	1.205	3.5	1.4	99.7
			NO	-0.1	2.6	1.210	3.5	1.5	
Grangemouth	04-Aug	1011836	NOx	1.0	2.5	1.015	3.5	0.7	99.6
			NO	-1.0	2.5	1.000	3.5	2.8	
Grangemouth Moray	04-Aug	1011852	NOx	1.0	2.6	1.120	3.5	1.1	100.9
			NO	0.0	2.8	1.121	3.5	0.7	
Inverness	14-Aug	1489	NOx	0.1	2.5	1.034	3.5	0.5	98.0
			NO	-0.1	2.5	1.020	3.5	0.3	
Peebles	05-Aug	2213	NOx	-2.1	2.6	1.065	3.5	0.6	100.4
			NO	0.3	2.5	1.080	3.5	0.8	
Welsh Sites									
Aston Hill	18-Aug	2302	NOx	0.8	2.5	0.849	3.5	1.6	99.1
			NO	0.5	2.5	0.848	3.5	1.6	
Cardiff Centre	24-Jul	14325	NOx	1.0	2.7	1.260	3.8	2.0	98.8
			NO	0.8	2.7	1.259	3.7	1.8	
Chepstow A48	21-Jul	1011828	NOx	2.0	3.2	1.186	3.5	0.8	100.9
			NO	-1.0	2.8	1.183	3.5	0.8	
Cwmbran	24-Jul		NOx	0.4	2.5	1.009	3.5	0.5	98.9
			NO	-0.1	2.5	1.041	3.5	0.5	
Narberth	22-Jul	14311	NOx	1.6	2.4	0.583	3.5	1.4	98.7
			NO	-0.2	2.4	0.589	3.5	0.9	
Newport	23-Jul	1011829	NOx	6.0	2.7	1.066	3.5	1.5	98.8
			NO	1.0	2.7	1.060	3.5	1.4	
Port Talbot Margam	23-Jul	12811	NOx	1.1	2.6	1.111	3.5	2.6	100.0
			NO	0.1	2.5	0.983	3.5	0.1	
Swansea Roadside	22-Jul	16695	NOx	2.9	2.7	1.070	3.5	1.6	98.0
			NO	0.3	2.6	1.112	3.5	1.2	
Wrexham	01-Jul	1490	NOx	4.6	2.5	1.038	3.5	0.3	99.9
			NO	-0.1	2.5	1.036	3.5	0.2	

5. Particulate Analysers

Site	Date Year =2014		Analyser number	Calculated Spring Constant k_0	[4]k_0 accuracy (%)	Uncertainty (%)	[3]Measured Main Flow (l/min)	Uncertainty (%)	[3]Measured Total Flow (l/min)	Uncertainty (%)
English Sites										
Barnstaple A39	07-Jul	PM10	660811	17296	0.1	1	3.05	2.2	16.23	2.2
		PM2.5	811002	14200	0.3	1	2.96	2.2	16.01	2.2
Birmingham Acocks Green	14-Jul	PM2.5	900702	15829	0.5	1	3.04	2.2	15.39	2.2
Birmingham Tyburn	14-Jul	PM10	90809	14869	-0.5	1	3.02	2.2	15.57	2.2
		PM2.5	60809	14725	0.3	1	3.06	2.2	15.43	2.2
Birmingham Tyburn Roadside	15-Jul	PM10	20603	12091	-2.3	1	2.92	2.2	15.72	2.2
		PM2.5	20606	14263	-1.2	1	3.12	2.2	14.97	2.2
Blackpool Marton	16-Jul	PM2.5		12503	-0.3	1	2.86	2.2	14.08	2.2
Bournemouth		GR2.5	21863						Not	tested
Brighton Preston Park	15-Jul	GR2.5	21865						16.38	2.2

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Bristol St Paul's	09-Jul	PM10 PM2.5	60302 95071	13315 13707	1.0 -1.5	1 1	3.03 3.01	2.2 2.2	16.61 16.25	2.2 2.2
Carlisle Roadside	15-Jul	PM10 PM2.5	600809 030810	14400 15078	-0.6 -0.6	1 1	2.93 2.60	2.2 2.2	15.79 15.12	2.2 2.2
Chatham Centre Roadside	03-Jul	PM10 PM2.5	710809 430810	14517 15987	0.0 -0.1	1 1	3.07 3.00	2.2 2.2	16.62 16.20	2.2 2.2
Chesterfield		PM10 PM2.5		Site	not	operating				
Chesterfield Roadside	22-Jul	PM10 PM2.5	999810 390810	11471 11022	1.1 -0.6	1 1	3.00 2.99	2.2 2.2	16.34 16.43	2.2 2.2
Coventry Memorial Park	06-Jun	PM2.5	890702	14865	-0.7	1	**2.93**	**2.2**	**16.49**	**2.2**
Eastbourne	15-Jul	PM10 PM2.5	380809 440809	14423 14854	-0.6 0.1	1 1	3.13 3.07	2.2 2.2	17.44 16.72	2.2 2.2
Harwell	26-Aug	PM10 PM2.5 GR10 GR2.5	 250302 439802 590603	14785 12396	-1.0 0.0	1 1	3.02 3.04	2.2 2.2	15.60 15.66 15.83 16.86	2.2 2.2 2.2 2.2
Hull Freetown	09-Jul	PM10 PM2.5	960301 510701	14182 13993	0.5 -1.4	1 1	3.29 2.75	2.2 2.2	16.36 17.17	2.2 2.2
Leamington Spa	10-Jul	PM10 PM2.5	510809 110810	14985 14169	-0.1 -0.1	1 1	2.97 2.90	2.2 2.2	15.22 14.92	2.2 2.2
Leamington Spa Rugby Road	10-Jul	PM10 PM2.5	 440809	 16000	 -0.2	instrument 1	fault 2.93	 2.2	 15.68	 2.2
Leeds Centre	09-Jul	PM10 PM2.5	221002 170808	13153 16896	-1.8 -0.8	1 1	3.18 2.41	2.2 2.2	17.71 17.63	2.2 2.2
Leeds Headingley Kerbside	09-Jul	PM10 PM2.5	921103 980808	17418 14583	-1.0 -0.8	1 1	2.88 2.66	2.2 2.2	16.23 16.18	2.2 2.2
Leicester Uni	07-Aug	PM2.5	490701	14700	-1.8	1	3.04	2.2	16.67	2.2
Liverpool Speke	03-Jul	PM10 PM2.5	500302 640702	15812 14818	0.0 -0.6	1 1	2.78 2.84	2.2 2.2	15.09 15.16	2.2 2.2
Manchester Piccadilly	19-Aug	PM2.5	089810	13975	-0.4	1	2.87	2.2	15.83	2.2
Middlesbrough	01-Aug	PM10 PM2.5	24325 2000	13973 15837	-1.1 -1.1	1 1	3.00 3.06	2.2 2.2	16.25 16.38	2.2 2.2
Newcastle Centre	30-Jul	PM10 PM2.5	24448 24447	13979 15042	1.1 1.4	1 1	3.05 3.01	2.2 2.2	15.92 15.62	2.2 2.2
Northampton Kingsthorpe	06-Aug	PM2.5	139902						16.34	2.2
Norwich Lakenfields	30-Jul	PM10 PM2.5	981105 180810	15620 15675	-0.6 0.5	1 1	3.20 3.04	2.2 2.2	16.70 16.56	2.2 2.2
Nottingham Centre	09-Jul	PM10 PM2.5	690811 250401	15567 12105	-0.1 -0.6	1 1	2.88 3.03	2.2 2.2	15.66 15.95	2.2 2.2
Oxford St Ebbes	26-Aug	PM10 PM2.5	960809 350808	14774 17199	-0.3 0.2	1 1	3.00 3.03	2.2 2.2	16.47 16.62	2.2 2.2
Plymouth Centre	08-Jul	PM10 PM2.5	 280302	12190 14252	-0.7 -0.6	1 1	2.87 3.06	2.2 2.2	15.80 16.37	2.2 2.2
Portsmouth	28-Aug	PM10 PM2.5	281101 500809	16799 18392	-1.1 -0.8	1 1	3.03 3.01	2.2 2.2	13.59 16.31	2.2 2.2
Preston	03-Sep	PM2.5	510108	12875	-0.6	1	2.85	2.2	14.68	2.2
Reading New Town	29-Aug	PM10 PM2.5	149610 750702	13141 13888	-0.4 -1.8	1 1	2.90 3.01	2.2 2.2	16.41 16.84	2.2 2.2
Rochester Stoke	03-Jul	PM10 PM2.5	410809 580809	14704 15922	-1.4 -0.1	1 1	3.02 3.02	2.2 2.2	16.55 16.57	2.2 2.2
Salford Eccles	20-Aug	PM10 PM2.5	979604 050807	13869 14395	1.3 -1.7	1 1	2.87 2.85	2.2 2.2	15.43 15.72	2.2 2.2
Saltash Callington Road	07-Jul	PM10 PM2.5	280210 860811	14118 12295	-0.2 -0.6	1 1	2.98 2.96	2.2 2.2	16.33 16.36	2.2 2.2

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Sandy Roadside	28-Jul 28-Jul	PM10 PM2.5	399707 841102	11316 15985	0.2 -0.6	1 1	3.07 3.02	2.2 2.2	14.87 16.40	2.2 2.2
Scunthorpe Town	08-Jul	PM10	100810	14912	-0.6	1	3.17	2.2	16.69	2.2
Sheffield Devonshire Grn	21-Jul 21-Jul	PM10 PM2.5		analyser analyser	fault fault					
Southampton Centre	12-Aug 12-Aug	PM10 PM2.5	560307 330808	13995 16519	0.9 0.0	1 1	2.95 2.91	2.2 2.2	16.02 15.77	2.2 2.2
Southend-on-Sea	01-Jul	PM2.5	230401	12383	-0.4	1	3.03	2.2	15.95	2.2
Stanford-le-Hope Roadside	30-Jun 30-Jun	PM10 PM2.5	180008 489804	12598 13153	-0.5 0.8	1 1	3.03 2.98	2.2 2.2	10.75 16.81	2.2 2.2
Stockton-on-Tees Eaglescliffe	31-Jul 31-Jul	PM10 PM2.5	h4554 h4553						15.70 15.60	2.2 2.2
Stoke-on-Trent Centre	30-Jun 30-Jun	PM10 PM2.5	280401 630809	12399 13447	-0.8 -0.4	1 1	3.03 3.06	2.2 2.2	16.19 16.37	2.2 2.2
Storrington Roadside	16-Jul 16-Jul	PM10 PM2.5	360808	15680 12864	0.0 0.9	1 1	5.26 2.99	2.2 2.2	19.04 16.21	2.2 2.2
Sunderland Silksworth	29-Jul	PM2.5	27247	15662	-0.9	1	3.01	2.2	16.76	2.2
Thurrock	30-Jun	PM10	290810	13996	-0.4	1	2.94	2.2	15.88	2.2
Warrington	02-Jul 02-Jul	PM10 PM2.5	830806 690809	11995 16331	-0.1 -0.2	1 1	3.02 3.01	2.2 2.2	15.90 15.95	2.2 2.2
Wigan Centre	20-Aug	PM2.5	910809	14773	-0.6	1	2.88	2.2	15.44	2.2
Wirral Tranmere	01-Jul	PM2.5	300001	13340	0.4	1	2.85	2.2	15.81	2.2
York Bootham	23-Jul 23-Jul	PM10 PM2.5	779712 090807	14543 16036	-1.3 -1.5	1 1	2.99 2.96	2.2 2.2	16.20 15.83	2.2 2.2
York Fishergate	08-Jul 08-Jul	PM10 PM2.5	060810 220808	15800 18052	0.6 -1.0	1 1	2.98 3.09	2.2 2.2	16.12 16.70	2.2 2.2
London Sites										
Camden Kerbside	13-Aug 13-Aug	PM10 PM2.5	529602 800009	12012 12966	0.2 1.6	1 1	3.22 3.08	2.2 2.2	16.26 16.11	2.2 2.2
Ealing Horn Lane	22-Jul	PM10	380810	15390	0.8	1	3.04	2.2	15.79	2.2
Haringey Roadside	11-Aug 11-Aug	PM10 PM2.5	600809	Analyser 13774	not -0.2	present 1	2.94	2.2	16.00	2.2
London Bexley	05-Aug	PM2.5	070401	11648	0.5	1	3.00	2.2	15.28	2.2
London Bloomsbury	06-Aug 06-Aug	PM10 PM2.5	460302 400809	13791 14712	0.4 -0.3	1 1	2.92 2.95	2.2 2.2	15.08 14.95	2.2 2.2
London Eltham	21-Jul	PM2.5	120801	14019	1.5	1	3.02	2.2	15.19	2.2
London Harlington	31-Jul 31-Jul	PM10 PM2.5	440311 920202	12306 12865	0.2 0.5	1 1	2.96 2.96	2.2 2.2	15.60 15.08	2.2 2.2
London Harrow Stanmore	13-Aug	PM2.5	740809	16061	-1.1	1	2.97	2.2	15.37	2.2
London Marylebone Road	24-Jul 24-Jul 24-Jul 24-Jul	PM10 PM2.5 GR10 GR2.5	410401 450809 430811 210001	13042 13003	-1.1 1.5	1 1	2.93 2.97	2.2 2.2	16.25 16.24 16.21 16.43	2.2 2.2 2.2 2.2
London N. Kensington	22-Jul 22-Jul 22-Jul 22-Jul	PM10 PM2.5 GR10 GR2.5	910811 890806 159902 199902	12726 15771	0.4 -0.1	1 1	3.25 3.21	2.2 2.2	16.80 15.94 16.80 16.74	2.2 2.2 2.2 2.2
London Teddington Bushy Park	14-Aug	PM2.5	650809	Analyser	failed	during	audit			
London Westminster	30-Jul	GR2.5	399811						16.19	2.2

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Southwark A2 Old Kent Road		PM10		site	not	operating				
Northern Irish Sites										
Armagh Roadside	28-Aug	PM10	450202	13563	-0.1	1	2.95	2.2	15.93	2.2
Belfast Centre	29-Aug	PM10	230303	14184	-0.1	1	3.09	2.2	16.57	2.2
	29-Aug	PM2.5	650702	15564	-1.1	1	3.10	2.2	16.58	2.2
Derry	20-Aug	PM10	830902	16099	1.8	1	2.86	2.2	15.35	2.2
	20-Aug	PM2.5	949608	10940	0.5	1	2.72	2.2	14.78	2.2
Lough Navar	18-Aug	PM10	999604	12995	1.4	1			15.64	2.2
Scottish Sites										
Aberdeen	13-Aug	PM10	270302	11683	1.0	1	3.03	2.2	16.13	2.2
	13-Aug	PM2.5	680811	12152	-0.6	1	2.79	2.2	16.36	2.2
Auchencorth Moss	06-Aug	PM10	390602	12931	-2.0	1	2.88	2.2	15.30	2.2
	06-Aug	PM2.5	033602	13617	-2.9	1	2.86	2.2	15.28	2.2
	06-Aug	GR10	500112						18.45	2.2
	06-Aug	GR2.5	480112						17.96	2.2
Edinburgh St Leonards	07-Jul	PM10	270808	13503	-1.4	1	3.02	2.2	16.37	2.2
	07-Jul	PM2.5	330808	16850	-0.9	1	3.04	2.2	16.12	2.2
Glasgow Kerbside	21-Jul	PM10	27344	14415	-1.1	1	2.52	2.2	15.67	2.2
	21-Jul	PM2.5	27337	15026	-0.6	1	2.88	2.2	14.35	2.2
Glasgow Townhead	21-Jul	PM10	27331	14584	-0.3	1	2.92	2.2	15.03	2.2
	21-Jul	PM2.5	22980	13091	-0.4	1	3.02	2.2	15.78	2.2
Grangemouth	04-Aug	PM10	280809	15769	-0.9	1	3.01	2.2	16.32	2.2
	04-Aug	PM2.5	590809	13517	-1.8	1	3.05	2.2	15.98	2.2
Inverness	14-Aug	GR10	550003						15.76	2.2
	14-Aug	GR2.5	610603						15.74	2.2
Welsh Sites										
Cardiff Centre	24-Jul	PM10	990701	13718	-1.2	1	2.89	2.2	16.02	2.2
	24-Jul	PM2.5	190401	11031	0.3	1	2.93	2.2	16.29	2.2
Chepstow A48	21-Jul	PM10	420809	14121	-0.4	1	2.97	2.2	16.18	2.2
	21-Jul	PM2.5	230808	15951	-0.3	1	3.00	2.2	16.36	2.2
Narberth	22-Jul	PM10	630702	13855	-0.1	1	2.89	2.2	16.03	2.2
Newport	23-Jul	PM10	029805	13835	-1.1	1	3.41	2.2	16.77	2.2
	23-Jul	PM2.5	660702	16445	-1.1	1	2.97	2.2	16.13	2.2
Port Talbot Margam	23-Jul	PM10	170807	13935	0.0	1	3.02	2.2	16.38	2.2
	23-Jul	PM2.5	900402	10550	-0.1	1	2.98	2.2	16.19	2.2
	23-Jul	GR10	389903						17.11	2.2
Swansea Roadside	22-Jul	PM10	M9305						9.79	2.2
	22-Jul	PM2.5	M9306						9.92	2.2
Wrexham	01-Jul	GR10	240001						16.27	2.2
	01-Jul	GR2.5	119902						16.51	2.2

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The above factors have been calculated using certified standards. The analysers listed above have been tested for zero response, calibration factor, linearity, converter efficiency (NOx analysers), m-xylene interference (SO_2 analysers), k_0 / main flow rate (for TEOM analysers) and total flow rate (for particulate analysers), by documented methods. Note that the test results are valid on the day of test only, as analyser drift over time cannot be quantified.

The calibration results for NOx, NO, CO, SO_2, O_3 and Particulates are those that fall within our scope of accreditation. Results marked with an asterisk (*) on this certificate fall outside our accreditation, but have been included for completeness.

[1] The zero response is the zero reading on the logging system of the analyser when audit zero gas was introduced to the analysers under test.
[2] The calibration factor is the multiplying factor required to scale the reading on the data logging system into concentration units (ppb for NO, NOx and SO_2, ppm for CO – 1ppm = 1000 ppb). It should be used in conjunction with the analyser output and the zero response, according to the following equation:

Concentration = (output – zero response) x Calibration factor

The scaling factor for gaseous analysers is calculated using mole fraction concentrations.

[3] The measured main flow rate (where this is applicable) is the flow rate through the sensor unit of a TEOM analyser. The measured aux flow rate (where this is applicable) is the flow rate through the bypass tubing of the TEOM particulate analyser under test. The measured total flow rate is the total flow rate through the particulate analyser under test. Units of flow are $l.min^{-1}$. Measurements shown in **bold** are not made at the normal sample inlet and may not therefore accurately represent the actual flow through the inlet.
[4] The k_0 accuracy value (specifically for TEOM analysers) indicates the closeness of the calculated result (in g/s^2 units) to the manufacturer's specified value of k_0.

* The maximum residual is the percentage maximum deviation of the worst linearity point from the line of best fit
* Converter is the measured efficiency of the NO_2 to NO converter in the Nitrogen Oxides analyser
* meta-xylene interference is the response of the SO_2 analyser when supplied with approx 1ppm meta-xylene.

This certificate is an electronic representation of a certificate signed by **Stewart Eaton sometime** and held by AEA at the above address. Hard copies are available on request.

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